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RAIN, HAIL AND SNOW.

BY HENRY D. BARROWS.

Some time ago there were published in the public press extracts from a paper by Lieut. Powell, of the Geological Survey, in which that officer discussed the question of Atmospheric pressure, etc., as connected with rainfall. Also Dr. J. P. Widney of this city, in a local journal, cited some of the minor causes affecting the *amount* of rainfall in a given section. But neither gentleman gave prominence to, or, so far as I saw, even touched upon, the prime factor in the causation of aqueous precipitation the world over, whether it be in the form of rain, hail or snow.

It may seem presumptuous for a layman or non-expert to criticise experts. Nevertheless, I take that liberty. I can at least set up a row of interrogation points, which they, or any other man, may "bowl over," if they can.

Of what avail are "pressure" and "cyclonic currents," etc., as rain-producers, if the moisture-laden currents of air move from a *cold* region to a *warm* one? Is not the effect of such relative transition—*i. e.*, from *cold* to *warm*—everywhere and always, to rarify the air, and to attenuate and dissipate—and *not* condense—the moisture, or vapor or clouds, in the air? And is not the effect of the transition of a moisture-bearing current of air, from a warm—no matter how warm—locality to a relatively colder one—as illustrated artificially in "the worm of the Still," in the distillation of Spirits—to chill, to retard and condense, and, if the change of temperature, from warm to cold, is great enough, to precipitate, in visible drops, the water carried in attenuated solution in the air current? Or, to state the matter in a nut-shell, does not *cold* serve as the grand condenser, and sifter and precipitator, of the aqueous particles that always float in air currents?

Is not, then, any attempted exposition of the theory of rain defective, that does not take into account *relative heat and cold* (through which wind currents move), and the effect of each, on both the air itself and the vapor it carries? Is it not a fact, universally recognized, that the *heat* rarifies, attenuates and makes lighter, the atmosphere? and does not every body also know that it has the same effect on water in its vaporous state—though it has a contrary effect on the latter in a frozen state, or when its temperature falls below 40 degrees, centigrade? And is it not evident without saying, that the converse of this statement *must* be true, namely that cold condenses air, and water also, when in a state of vapor?

Furthermore, is not this true in each case when the heat and cold are only relative? Is not moisture as readily precipitated in the tropics, where air currents of 100° Fahr. and upwards are forced in the direction of a relatively colder temperature, as it is in the temperate or arctic zones, although the *warm* region of the latter (*from* which the currents come) may be many degrees *colder* than the *cold* region of the former (*towards* which they are driven)? And is not a discussion of atmospheric pressure or of air currents, cyclonic or other, in connection with the causation of rain, without reference to relative heat and cold, as incomplete and unsatisfactory as would be the play of *Hamlet* with the part of Hamlet left out?

If the temperature of the great ocean of air which envelopes the earth were uniform or unchangeable, if such a state were supposable, *i. e.*, if air currents always moved in an even unvarying temperature, the phenomenon of rain would probably be unknown. The watery particles that are constantly rising by evaporation would, of course, after the air had become surcharged with them, seek the earth again, perhaps in the form of mist, but *not* in the form of rainfall—*i. e.*, of visible drops of water in mid-air. Much less would this happen with currents moving from a cold to a relatively warmer region. Indeed, in this latter case, would not the precipitation of visible drops of water be an impossibility? Spirit-vapor in a still-worm ending in a heated furnace *will not* materialize in visible drops. Every body in cold countries is familiar with the phenomenon of the formation of visible moisture on the window-pane from one's breath. But if the glass be in close proximity to a hot fire, no moisture will distil on it from the relatively cooler human breath. It would be contrary to a simple natural law. Therefore I repeat: *Relative Cold* is the grand condenser, in connection with air currents, without which, these latter would be utterly inefficient as rain-producers. There is one other very important point that I have not mentioned, that has vastly more to do in the causation of rain than is generally supposed. It is known that frost is perpetual in the Polar regions at the surface of the earth; whilst at say 50° North or South latitude, the perpetual snow line is only a little over a mile high, and at the Equator it is only about three miles high. What the intensity of the cold is, at the height of ten or twenty or fifty miles, we know not. The sun's rays only heat by refraction from the earth's surface the lower strata of air, on which the higher and immensely colder strata are constantly impending or pressing. When there is a general lateral movement of the air near the earth's surface, from the Equatorial towards the Polar regions, the cold that the air currents naturally meet tends to condense the moisture they bear; but the super-incumbent cold air above, ever pressing downwards, conduces powerfully—we know not how powerfully—to increase the condensation: and thus we have the phenomenon, which has always seemed to me a sort of miracle, to wit, the formation of large drops of water from vapor in mid-air!

When all the various causes that produce rain, co-operate, and the temperature into which the condensed vapors are driven falls below the freezing point, they are precipitated in the form of snow or sleet or hail.

Again: The mere local and minor causes affecting the *amount* of rain-fall, etc., of which our townsman, Dr. Widney, speaks are only operative in connection with the major and vastly more important causes of rain, to wit: a grand movement of the atmosphere extending over a large area; and 2nd, this movement must be in the right direction, that is to say, it must be *from a warm to a relatively colder* region. When these conditions prevail, and the pressure is considerable, of course, the obstructions of high mountains, especially if their tops are covered with snow; and of extensive forests, will tend to increase the local precipitation; and the earth in a given locality, will, as a rule, absorb and retain the rain-fall more effectually if it is cultivated, than if not. But all these local causes, however useful under certain conditions, are of no avail without the presence of the major or larger causes; and their influence in inducing the latter, to wit, a general movement of the lower strata of the atmosphere over an extended area, towards the Polar regions, must be infinitesimal: in my opinion, it is absolutely *nil.*

I do not know if it be worth while, or if it is at all necessary to further illustrate the position I assume, namely, that *relative cold* is absolutely indispensable in connection with atmospheric currents to produce rain-fall; and that *relative heat* as certainly tends to dissipate moisture. Our own wet and dry seasons aptly illustrate both these principles. Whenever the sun is north of the Equator it heats and rarifies the air over the immense desert region east of us, causing the air to rush in to fill the vacuum. The suction of this inverted maelstrom is so strong that it overcomes all the ordinary or normal processes by which rain is produced elsewhere, and would be here except for this powerful disturbing cause. It even extends, as "Old Salts" tell us, several hundred miles out to sea, and diverts inland each day the trade-winds, that otherwise would blow towards the south-west during six months in the year. As the sun rises and heats up with tremendous power the sands of the desert, the wind rises, and continues till the sun goes down, when the wind goes down. Then, at nightfall, as the desert cools quickly, and the water of the ocean, having been heated to a considerable depth, cools slowly, a wind from the land springs up and blows towards the ocean. Thus, when the sun is north of the Equator, we have, each day with invariable regularity, a " sea-breeze," and each night, though with much less regularity, a "land-breeze." When the sun goes south in winter and ceases to heat up the desert, it becomes possible for southerly winds to prevail; and then rain-fall here, as in other parts of the world, becomes possible.

Our position between an ocean and a desert makes our climate unique. We have that exceedingly rare thing, a tropical climate without tropical heats, thus enabling people of the Caucasian race and of northern countries to live in comfort, in a country where the orange grows. If, however, a continent instead of an ocean were west of us, our daily summer winds would be hot instead of cool—as our summer "northers" are—and as a consequence our summers would be intolerable for northern people. Or, on the other hand, if the Colorado Desert east of us were, as it once was, an arm of the sea, we would no longer have dry summers.

I will close with one more illustration of the effect of heat and cold on vapor-laden air currents.

Several years ago I had occasion to cross the arm of the Mojave Desert, between the Soledad and Tehachapi mountains, on the present line of the Southern Pacific Railway. It was in the month of January, and a snow and sleet storm was prevailing at the time on those mountains, but *not* on the desert between them. It was an interesting sight to witness what appeared to be the parting of the clouds as they came over the desert, but which was in fact their sudden dissolution and dissipation. Dense masses of them in rapid succession melted away and disappeared before my eyes in a twinkling! Whilst the storm continued to rage on both mountain ranges, as we could see, the sudden warmth of the desert caused the clouds between to disappear as if by magic. I had often before watched the slow process of dissolving clouds after a storm, till the gradually attenuating vapor finally became invisible. But in this case, the transition from *cold* to *warm* was so sudden, that the storm-clouds that had just been discharging their burden on the cold mountain ranges, all at once, as they came to the desert, dissolved into thin air. And thus, within a space of twenty or thirty miles, I saw the strange spectacle of a snow-storm on two mountain ranges, and blue sky over the desert between! The temperature changed so suddenly from the mountains to the valley, that expansion, rarification and extreme attenuation set in at once, and dense vapor became invisible by a process, extremely rapid, but analagous to that which we see exemplified every day in summer, by the licking up of the moisture in the atmosphere around us—whether invisible or in the form of clouds or of fogs from the ocean—and carrying the same inland and depositing it in the great all-consuming vortex created by the abnormal heat of the desert.